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GB 2230814 A GB 2151290 A GB 1430653 A
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(54) **Suspended staging**

(57) A suspended staging system 1 for emergency or normal use in offshore applications comprises a series of platforms 2 slidably mounted on guide wires 14 and linked by chains 3 to form a collapsible stack. The guide wires are tensioned by one or more weights 16 below the lowest platform. In use, when the system is fully deployed, the lowermost platform is arranged to be submerged in substantially all sea conditions. The guide wires 14 extend through guide means 15 on each platform and 17 on handrails between the platforms. A flexible line 32 may be attached to the bottom of the staging system for deployment with the staging for launch of a life raft 30.

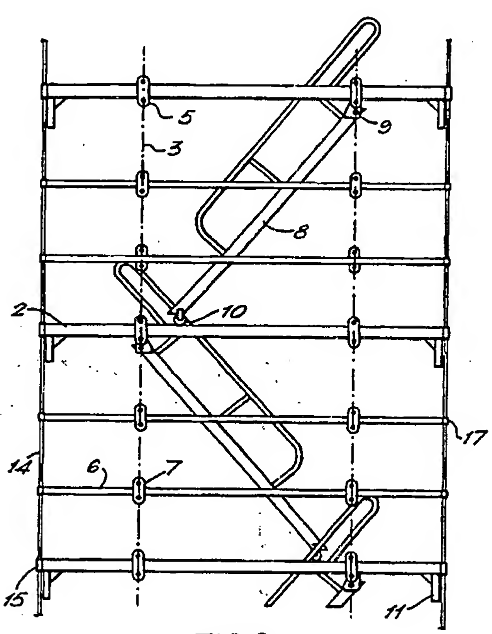

FIG.2.

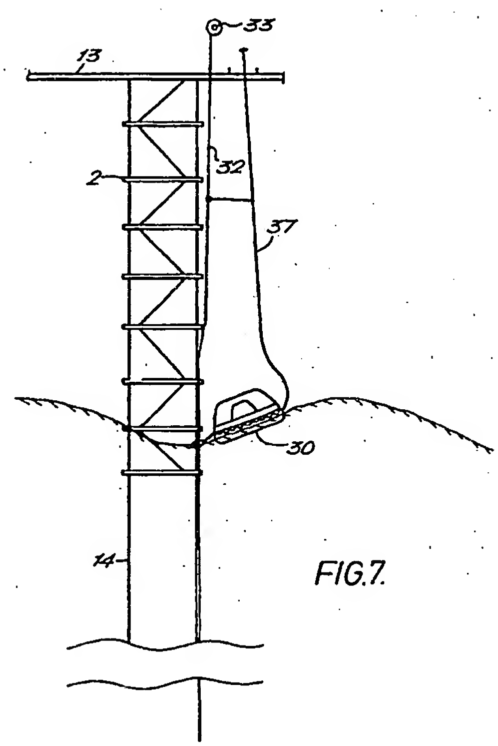

FIG.7.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

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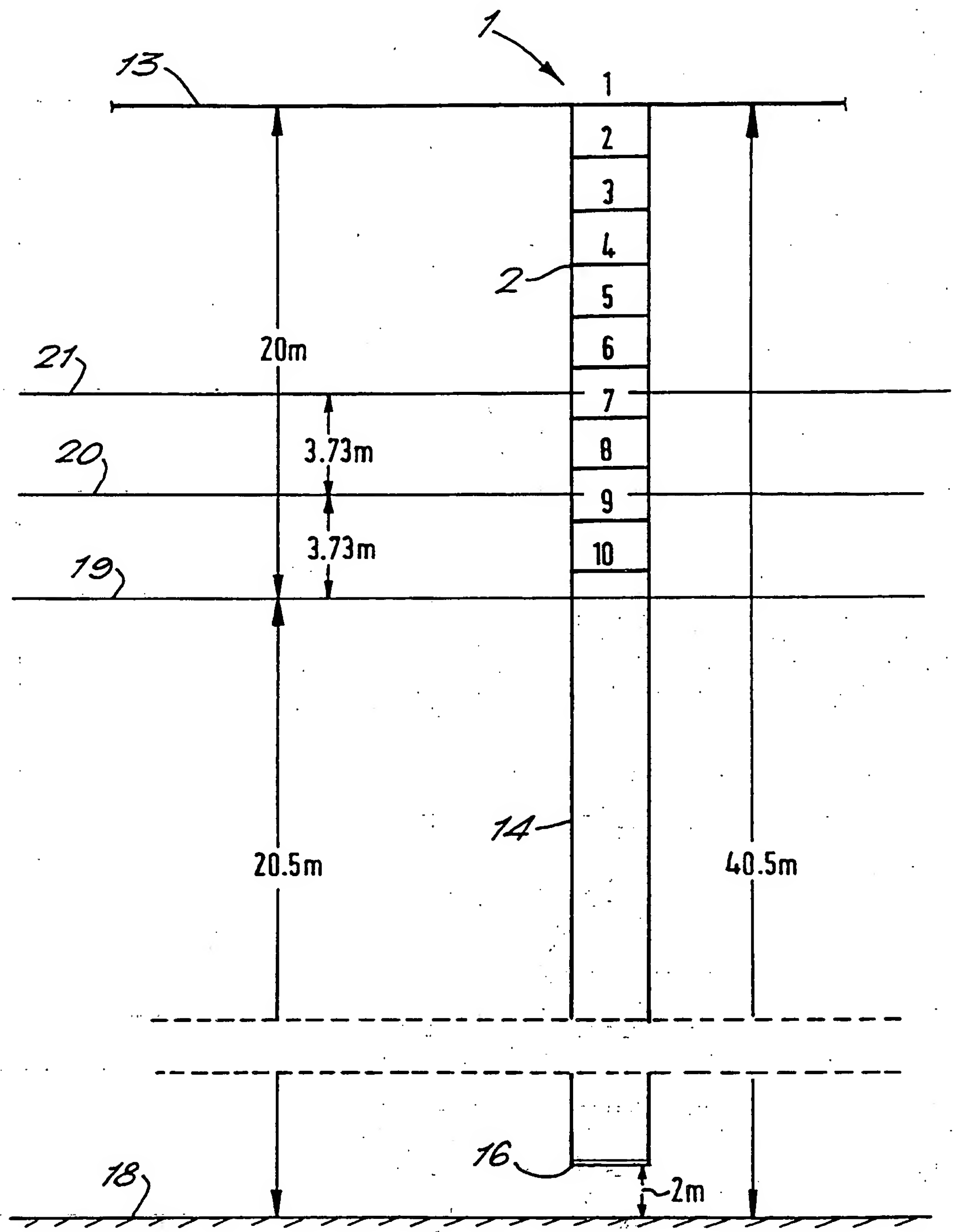
FIG.1.



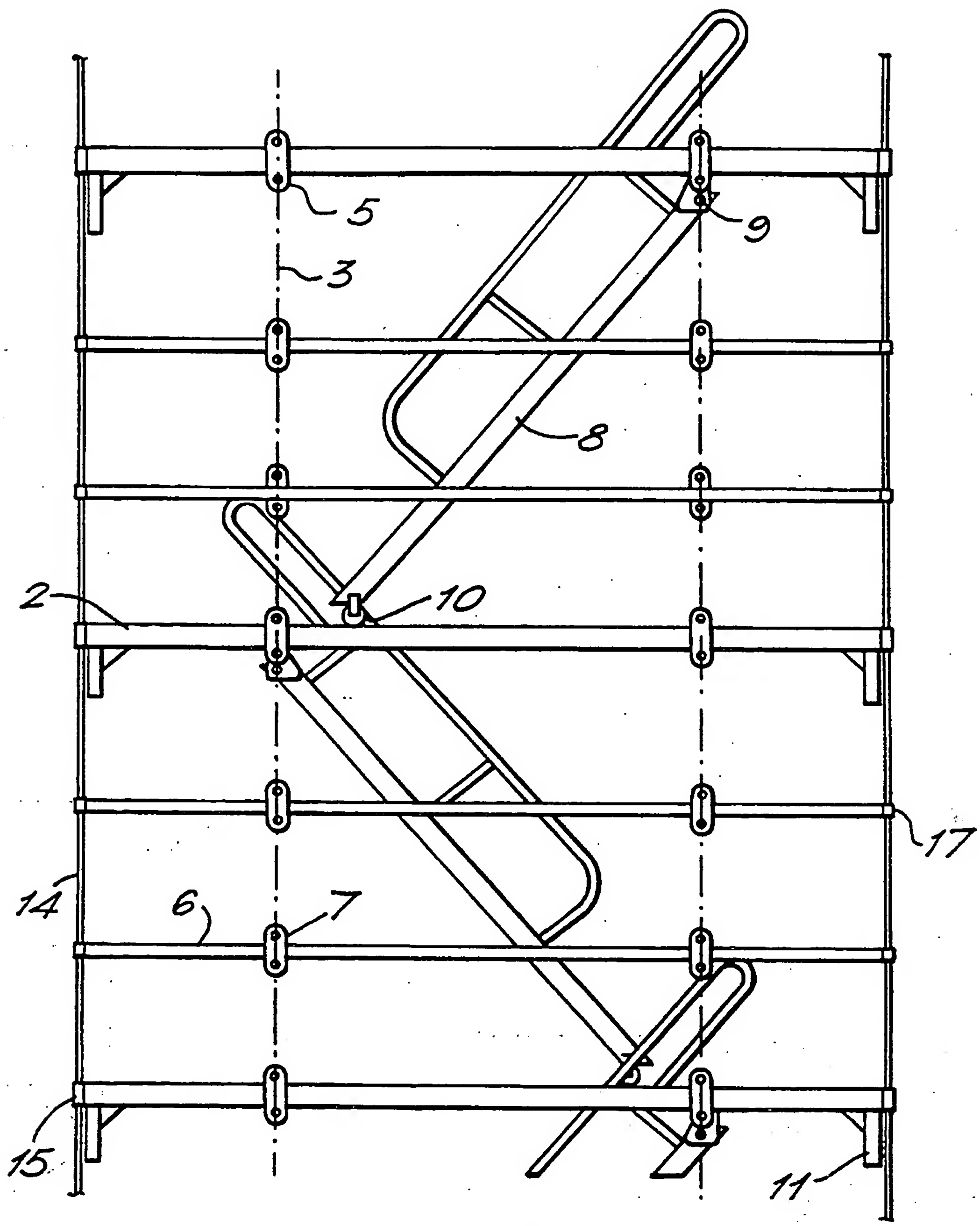


FIG.2.

FIG. 3.

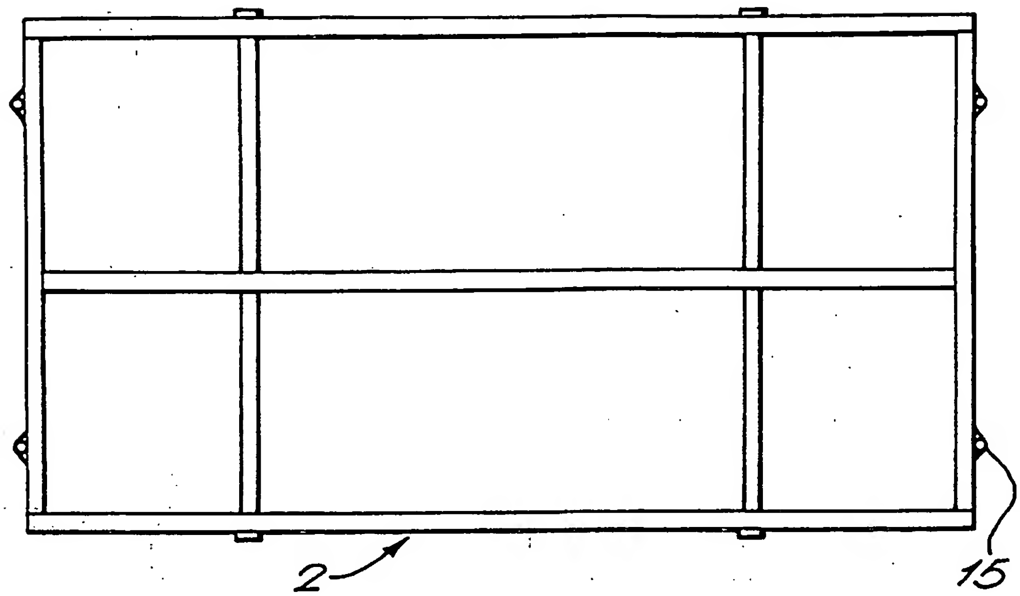
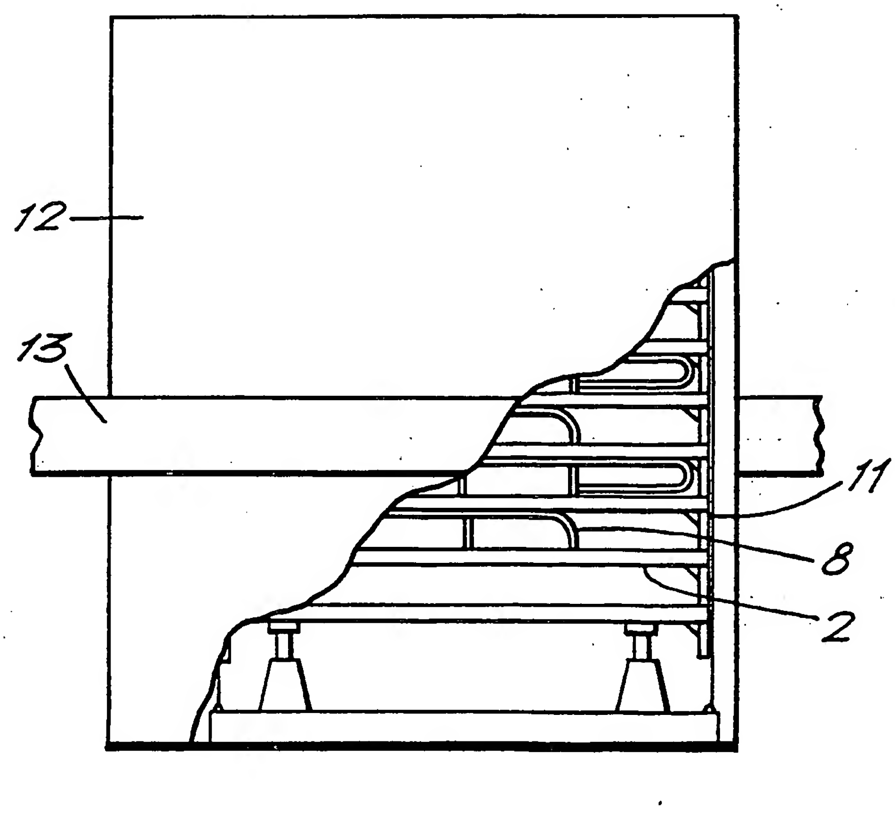


FIG. 4.



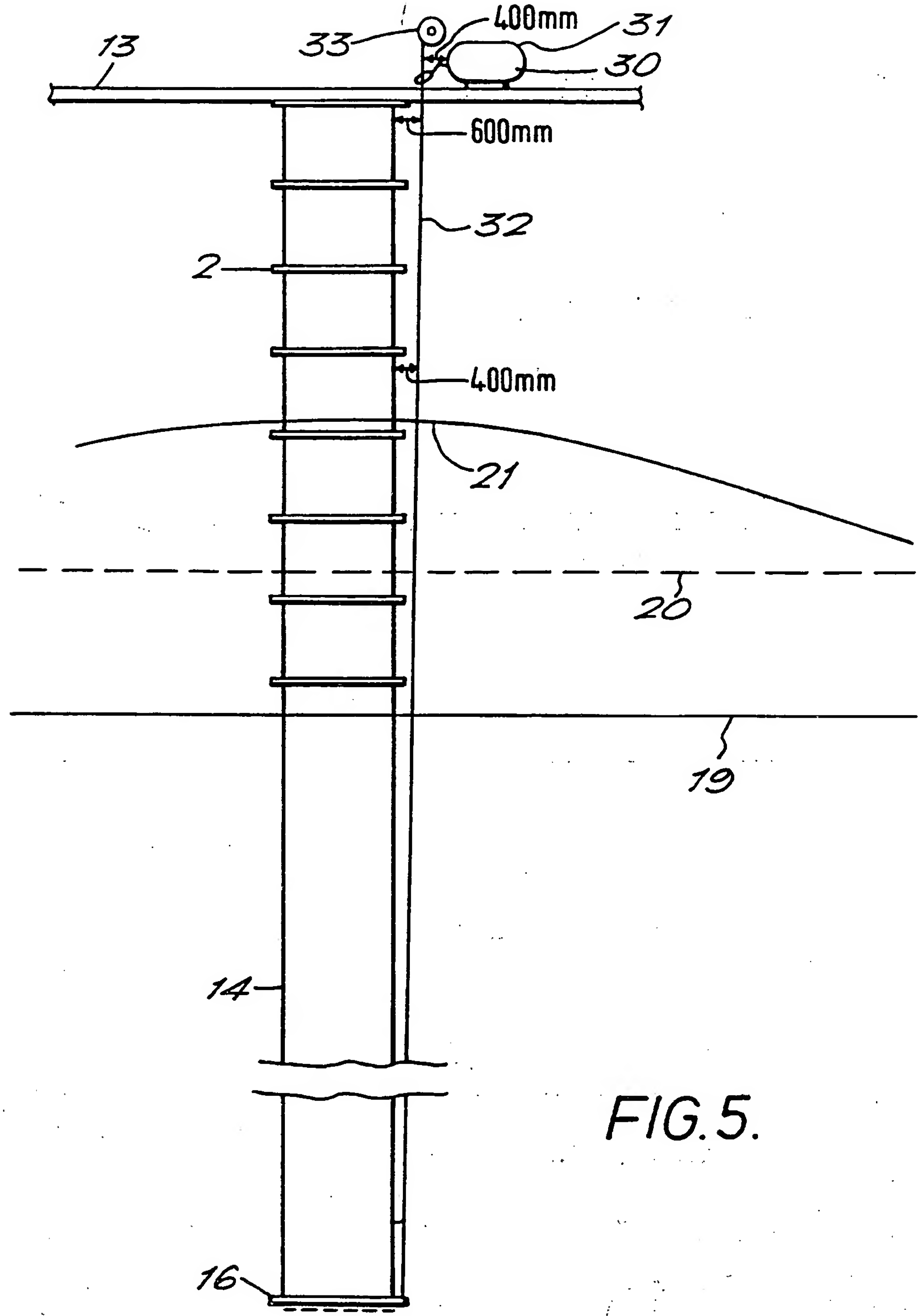


FIG. 5.

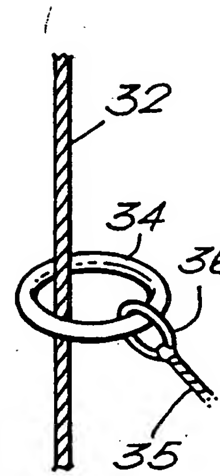


FIG.6.

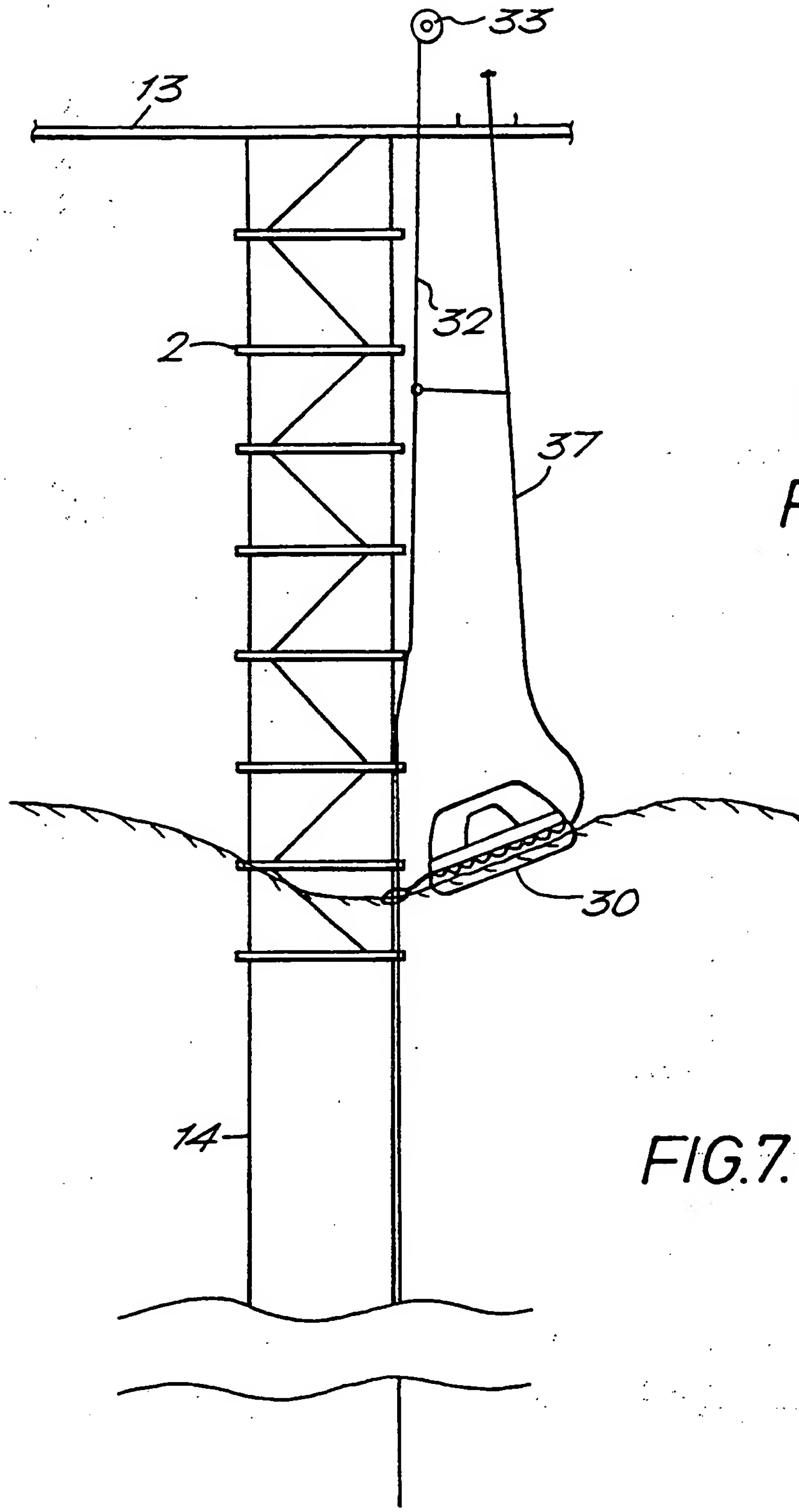


FIG.7.

Suspended Staging

This invention relates to suspended staging and more particularly to suspended staging forming a collapsible escape and/or access stairway for use in offshore environments.

The staging comprises a series of platforms each connected to the adjacent upper and lower platform by respective flexible elongate elements such as chains or cables, so as to be collapsible into a stack. In a deployed state each platform is suspended spaced from the one above by any suitable number of flexible elongate elements eg. four chains or the like. The flexible elongate elements may be attached to the platforms by any convenient means such as by link plates. One or more safety handrails are preferably supported on the flexible elongate elements between each platform, also by any appropriate means eg. link plates.

A series of ladders or other descent/ascent means is provided between the platforms to allow personnel to move up and/or down the deployed staging. Ladders or other descent means may be removably positioned between the platforms, but in a preferred arrangement a ladder is hingedly attached below each platform such that it automatically adopts a suitable position in use extending between adjacent platforms when the staging is deployed. Openings in the floor of each platform may be provided for access to the ladder below.

Preferably the ladders are each provided with one or more rollers at the lower end to better accommodate relative movement of the platforms towards and away from each other, as the staging is deployed and/or collapsed or subjected to environmental and other loading.

Preferably stop means are provided on each platform for holding the platforms apart from each other when collapsed into a stack to prevent damage to link plates,

ladders and other components.

The platforms are advantageously stored in a collapsed condition to minimise the risk of environmental and other damage, and are deployed for use. A housing may be provided for the collapsed stack at or near the suspension point. The platforms may be deployed by lowering the entire stack supported on the lowermost platform until each successive platform from the top of the stack downwards reaches its deployed position determined by the lengths of the respective interconnecting flexible elongate members and is thereby lifted from the stack.

One means of lowering the lowermost platform is by means of one or more elongate flexible guide elements connected to the lowest platform or more preferably connected to one or more weights below the lowest platform. Preferably the one or more guide elements extend through guide means located on each platform, such as an eg. circular or tubular opening in the platform, bushes formed of a suitably wear resistant material eg. nylon, or suitable bearings. One advantageous aspect of at least preferred embodiments of this invention is the provision of guide means for said one or more guide elements on at least one handrail between each of the platforms. Preferably all sets of handrails are provided with such guide means, which may for example comprise a tubular opening formed at an appropriate position in the handrail. The rigidity of the system is thereby increased at least when more than one such guide element is provided, and such an arrangement helps to keep the handrails aligned with the platforms at all times.

Any number of guide elements e.g 1, 2 or 4 may be provided, but in a particularly stable arrangement there are four guide elements extending through four symmetrically located guide means on each platform. The applicant has found that it is particularly advantageous

to provide a platform having a generally rectangular shape and to locate two guide means on each short edge of the platform, spaced from each other and from the longer edges of the platform. This has been found to provide good stability particularly against torsion under environmental loading, particularly due to wave action.

In arrangements in which one or more guide elements are connected to one or more weights below the lowest platform, the weight or weights is/are submerged below sea level in use. In a preferred arrangement four guide elements are connected below the lowest platform to a single weight. The weighting of the guide elements adds stability to the staging, by tensioning the guide elements to increase the rigidity of the column, and submerging the weight below sea level tends to reduce movements of the staging in response to wind loading and other factors.

A particularly advantageous feature of at least preferred embodiments in the location of one or more weights attached to the guide elements at a substantial depth below sea level, which has been found to give a high degree of stability. The optimum depth of the submerged weight will depend on a variety of conditions, such as the water depth, the height of the staging between the top and lowest platform, the number of platforms, local sea currents and expected wave and wind loading. One significant factor may be the need to reach an optimisation between the conflicting effects of decreasing wave forces and reduced transverse stiffness as the depth is increased. However, at least in preferred embodiments the weight will be located at a sufficient depth to substantially avoid the effects of wave action (or at least the worst effects), up to depths to within about 2m of the sea floor. Typically the weight may be located at a depth of between about 20 to 60m below sea level in a range of environments. In

deeper water, depths of about 35 to 55m may be preferable.

The applicant has also found that in such systems the mass of the submerged weight(s) may be important. An increase in the mass may reduce the displacements of the staging under wind, wave and current loading, and may also reduce movement of the weight(s) due to sea currents. However, beneficial effects on the response of the system are not necessarily maintained if the mass is increased beyond a certain point, and the dynamic response of the system may even deteriorate with a very large mass. Disadvantages may also arise if the tension on the guide elements is very large. An optimum mass has been found in certain applications to lie between about 2 and 4 tonnes and preferably about 3 tonnes.

In some circumstances it has been found that the shape of the weight(s) may have an effect on the response of the system to environmental loading, particularly where there are strong sea currents. In some circumstances it may be desirable to increase or reduce the area and drag effect of the weight(s) eg. by using grillages or streamlining. For example, in some circumstances increasing the cross-sectional area of the weight(s) may have a desirable damping effect on system displacement, whereas in other circumstances where there are stronger sea currents a smaller area may be desirable. It may also be advantageous to alter the size or shape of the weight depending on whether sea currents tend to oppose prevailing wind and wave loading or act in the same direction. In practice however, the effect of the shape of the weight may not be very significant in most applications.

It should be appreciated that movements of the described system as a whole in response to wind, current and principally wave action will be affected by a range of factors. The depth of the submerged weight(s) is an important factor which may in turn be influenced by the

water depth, and other possible considerations which have already been discussed are the mass and possibly the shape of the weight(s). Another important factor which will be discussed in more detail below is the air gap from the top platform or point of entry to the system down to sea level, which will affect the number of platforms to be used. The overall dimensions and mass of the system including platform spacing may also be significant. For any set of environmental and structural conditions including in particular water depth and air gap, a different configuration of the system including in particular depth of weight and number of platforms may be optimal. For each application an optimum configuration can be found using mathematical or experimental techniques. Advantageously a data bank is provided from which the system behaviour of a wide variety of configurations can be assessed. Such a data bank can be built up from mathematical modelling, experimental results or preferably a combination of both of these methods, and may be displayed in graphic or tabular form, if desired by computer.

Suspended staging systems have hitherto been proposed for use as escape systems in offshore applications, and have been intended for only a single deployment before being removed and taken onshore for checking, maintenance and restacking. Preferred embodiments of the present invention are adapted to be permanently installed offshore, that is preferred embodiments can be retracted after use into a collapsed condition so as to be available for further use, and can also be maintained and tested in situ. Preferably the staging is deployed by releasing a gravity brake and recovered by use of a winch.

Preferred embodiments are also adapted for use as an access system for non-emergency descent from and access to an offshore installation. One feature which

is advantageous particularly but not exclusively in situations where the staging is used as an access system is the provision of remote control means facilitating lowering and/or raising of the staging remotely eg. from an approaching vessel.

As mentioned above, further factors which may effect the response of the system to environmental loading are the number, size and spacing of the platforms. It has been found for example that a more stable arrangement can be achieved with relatively compact platforms which have a relatively small spacing, although clearly the need to move personnel rapidly and safely from platform to platform will also be a factor in this regard.

Advantageously the number of platforms is selected having regard to the lowest expected astronomical tide to ensure that at least one of the lower platforms is submerged in substantially all tidal and wave conditions. At higher tides and sea states two or more platforms may be submerged. It has been found that the submersal of lower platforms of the stack can be achieved without substantial detrimental effect on the response of the system to environmental factors. Lowering the staging until at least the lowest platform is submerged facilitates onward escape of personnel into rescue craft or by rafts and use of the staging as an access system.

In determining the behaviour of various configurations of the system as discussed previously, the behaviour of the lowest platform above water can be taken as a good indication of the performance of the system at various water depths, depths of weight, air gaps and number of platforms. For example the behaviour ie. displacement of the lowest platform above water could be compiled for air gaps (between top platform to lowest astronomical tide) from 10m to 25m and water depths (from lowest astronomical tide to sea floor) up

to 50m.

In order to facilitate movement of personnel to and from whichever of the lower platforms is appropriate depending on sea conditions, advantageously the handrails are arranged to permit easy passage of a person therebetween. Preferably only two sets of hand rails are provided at least between the lower platforms eg. the three lowest platforms to provide adequate safety whilst permitting a sufficient spacing between handrails to allow personnel wearing survival suits and/or life jackets to climb therethrough.

Preferably said lower platforms are provided with additional removable deck flooring which can be placed over a ladder access opening to prevent persons falling therethrough, eg. whilst awaiting rescue.

The applicant has also devised a new method and arrangement for deploying a life raft for use with a collapsible stairway, such as a suspended staging system having one or more of the features hitherto described. The system comprises a flexible line adjacent the collapsible stairway which is arranged to be deployed automatically with deployment of the stairway. For example, the line may be housed on a self reeling drum adjacent the top of the stairway and be attached to a lower point on the stairway so as to be automatically unreeled as the stairway is lowered. In a system having a weight suspended below the stairway such as has been described above, the flexible line is conveniently attached to said weight.

After the flexible line has been deployed a life raft attached to the line can be lowered to the sea surface for personnel escaping from the lower end of the stairway. Conveniently a life raft is attached by a short flexible connection to slidable guide means such as a ring, sleeve or the like mounted about said line. Preferably the ring or the like has a substantial clearance about the line so as to slide freely

therealong. One suitable flexible connection between the ring or the like and life raft comprises a short flexible line provided with a loop or ring connector at each end.

Preferably said ring or the like which is slidably mounted on the flexible line is buoyant so as to float on the sea surface.

Preferably the lift raft is allowed to fall under gravity from a location on the offshore installation adjacent the top of the stairway to the sea surface. The line is preferably deployed in close proximity to the collapsible stairway for ease of transfer of personnel to the life raft. For example, the flexible line may be unreeled from a point on the offshore installation less than 1 metre from the top of the collapsible stairway, and may be attached in even closer proximity to the lower end of the stairway so as to taper downwardly towards the stairway. In one embodiment the flexible line is deployed from a point 0.6 metres from the stairway and a life raft is launched from a point approximately 1m from the stairway. Even with the life raft in close proximity to the stairway the arrangement being such that the raft can fall freely under its own weight ensures that there is no possibility of the raft striking the system on descent.

When the life raft is not in use it can be stored eg. in a cradle, preferably at the point of launch. The raft may be stored in an uninflated condition and may be adapted to be inflated from the platform after launch in a conventional manner.

In practice, once the flexible line has been deployed with the stairway, and the life raft has been launched a user descends to a lowest safe point and ties off the flexible line to the stairway. Personnel descending the stairway can then step or jump directly from the stairway into the raft.

The life raft may further be connected to the

offshore installation by means of a painter.

Various novel and inventive aspects and features have been described herein, and protection is sought for any or all of these aspects and features individually and in any combination whether or not specifically so indicated.

A suspended staging incorporating some of the above features will now be described by way of example only, with reference to the accompanying drawings, wherein:-

Figure 1 is a schematic side view showing the basic configuration of the system;

Figure 2 is a side view showing the ladder arrangement between two platforms;

Figure 3 is a schematic plan view of one platform showing the location of the guide means;

Figure 4 is a side view showing the staging in a collapsed condition with the housing partially broken away;

Figure 5 is a schematic side view showing the flexible line for life raft deployment;

Figure 6 shows a perspective view of a means of attaching a life raft to the flexible line; and

Figure 7 shows a schematic side view of the life raft when deployed.

Figures 1 to 4 shows a suspended staging system 1 comprising ten platforms 2 interconnected by a series of four chains 3 extending between link plates 5 attached to each platform. Two sets of handrails 6 are connected by link plates 7 to said chains 3 between each platform 2. There is sufficient spacing between the handrails 6 to permit a person to climb between the handrails 6 on to or from the platforms 2. Lighting (not shown) is provided on each platform.

Each platform 2 is connected to the adjacent platform below by means of a ladder 8 which is hingedly attached at a point 9 below the platform 2. An access opening (not shown) is provided in each platform 2 for

access to the ladder 8. Each ladder 8 is provided with a roller 10 at its lower end which is slidable relative to the adjacent platform therebelow as the stack 1 is deployed or collapsed and to accommodate relative lateral movement between the platforms.

As can best be seen in Figures 2 and 4, stop means 11 are provided below each platform to keep the platforms spaced apart in a collapsed condition sufficiently to avoid damage to the ladders 8. When the staging is not in use it is stored collapsed in a housing 12 at deck level 13 as shown in Figure 4.

Four guide wires 14 extend through nylon bushes 15 on each platform and are connected to a three tonne weight 16 below the lowest platform. As can be seen in Figure 3, the platforms 2 are rectangular in plan view and two guides 15 are located on each short edge, spaced from each other and from the long edges of the platform. The illustrated platform has dimensions 1.8m by 3.4m and the guides are located 0.3m from the corners on each short edge, spaced apart by 1.2m. That is, the guides are each spaced from the corners on the short edges by about one sixth of the dimension of the short edges. Such has been found to be a particularly stable arrangement.

The guide wires 14 also extend through tubular guides 17 located on each of the handrails 6 on that portion of the handrails 6 which extends along the short edges of the platforms 2. This arrangement keeps the handrails 6 in alignment with the platforms 2 and provides additional rigidity to the structure.

In use, the system 1 is deployed under its own weight from its collapsed condition on release of a gravity brake (not shown). The release of the gravity brake allows the guide wires 14 to deploy to lower weight 16 to a position 2 metres above the sea bed 18, which in the illustrated system is 20.5 metres below the lowest astronomical tide level 19. As the weight 16

falls under gravity the platforms 2 supported on the weight fall with it until each in turn is lifted from the stack as the chains 3 connecting it to the platform above become taught.

In the fully deployed condition the lowest platform is positioned at or close to the lowest astronomical tide (l.a.t.) level 19. The lowest two platforms 2 are located below the maximum tide and storm surge level 20 calculated to be 3.73m above l.a.t. and the four lowest platforms 2 are located below the maximum tide and storm surge with F.7 waves level 21 calculated to be 7.46m above l.a.t. Thus in practice at all times at least one of the lower platforms 2 is submerged. This allows easy access to or from the lower platforms from or to another vessel or life raft in all conditions. Additional flooring (not shown) is provided on the three lowest platforms which can be removably placed over the ladder access openings (not shown) for safety whilst personnel are accessing those platforms.

In the illustrated embodiment the air gap between the top platform 2 and the l.a.t. level 19 is 20 metres, the deployed platforms 2 being spaced by 2.1 metres from each other.

The behaviour of the lowest platform 2 or of the lowest platform 2 which is not submerged gives a good indication of the stability of the system. For example, the horizontal displacement of the illustrated system has been measured in various environmental conditions using experimental and mathematical modelling techniques and has been found to be within acceptable limits in all environmental conditions. For example in sea state 7 with a wave height of 7.5m, a wind speed of 40 knots, a current speed of 0.4 m/s and two platforms submerged the mean horizontal displacement of the lowest platform has been found to be 0.884 metres (standard deviation 0.621) and the mean horizontal displacement of the lowest platform which is not submerged (ie. the third from

lowest platform) has been found to be 0.785 metres (standard deviation 0.471). The illustrated number of platforms 2 (ie. ten platforms) and depth of weight 16 has been found to be optimum for the water depth between l.a.t. 19 and the sea bed 18 and the air gap between the top platform 2 at deck level 13 and l.a.t. 19.

The system 1 can be used not only as an escape system for emergency use, but also as an access system. Winch means (not shown) are provided comprising a centrally located drive motor connected to four drums for the guide wires 14, the drums being located above the suspended stack 1 at the corners of an approximately 2 metres by 3.7 metres rectangle. Said winch means can be used to wind in the guide wires 14 raising the weight 16 and successive platforms 2 to collapse the stack after use. The release of the gravity brake and operation of the winch means can be performed remotely eg. by personnel in a vessel on the sea surface approaching or leaving the staging.

The system 1 can be maintained and tested in situ and thus once it has been installed it can be deployed, collapsed for storage away from the elements and redeployed on successive occasions without having to be brought onshore. All components are able to withstand harsh environmental conditions, being galvanised or sheradised where possible.

Figures 5 to 7 illustrate the deployment of an inflatable life raft 30 for use with the suspended staging system 1 or any similar collapsible stairway. The life raft 30 is shown deflated in a storage position in a cradle 31 on deck 13 in Figure 5 and inflated after launch on the sea surface in Figure 7.

The life raft deployment system comprises a stainless steel wire 32 which is reeled on a self reeling drum 33 located above the level of the top platform 2 and 0.6 metres horizontally to one side of the platforms 2. The lower end of the wire 32 is

attached to stabilising weight 16 of the suspended staging system 1. Thus, when the suspended staging 1 is deployed from its collapsed condition the wire 32 is automatically unreeled into the position shown in Figure 5. The wire 32 tapers inwardly towards the stack and the attachment point on weight 16, and the lowest platform which is not submerged is only 0.4m from the staging.

The life raft 30 is attached to the wire 32 by means of a buoyant ring 34 which has a large clearance about the wire 32 so as to slide freely therealong. A very short length of flexible line 35 connects the ring 34 with the life raft 30 by means of a loop 36 at either end. The life raft 30 is also connected to the offshore installation at or above deck level 13 by means of a painter 37.

In use, once the staging has been deployed the deflated life raft 30 is launched from its cradle 31 on the deck 13 spaced horizontally approximately 1 metre from the staging 1. The life raft 30 falls under its own weight to the sea surface, the weight of the life raft 30 and free slidability of the ring 34 on wire 32 ensuring that the life raft does not strike the staging on its descent. After launch the life raft 30 is inflated from the deck 13 in a conventional manner. A user descends from the deck 13 to the lowest safe platform 2 above the sea surface and ties off the wire 32 to fix the life raft closer to the staging 1. Personnel descending down the staging 1 can then step into the life raft to escape the installation.

It will be appreciated that the inventive aspects and features discussed herein are not necessarily limited by the illustrated embodiment which is by way of example only. It is desired to protect each of the aspects and features described herein individually and in any combination and including modifications which will be apparent to those skilled in the art.

Claims

1. A suspended staging system for use in offshore applications, comprising a series of platforms each connected to the adjacent upper and lower platform by respective flexible elongate elements, and a plurality of flexible guide elements connected to one or more weights below the lowest platform and extending slidably through guide means provided on each platform so that successive platforms can be raised and lowered by raising and lowering the one or more weights, the arrangement being such that the one or more weights and at least the lowermost platform is submerged in use in substantially all tidal and wave conditions when the staging is fully deployed.

2. A suspended staging system as claimed in claim 1, wherein four flexible guide elements are connected to a single weight below the lowest platform.

3. A suspended staging system as claimed in claim 2, wherein said platforms are generally rectangular and said four guide elements extend slidably through spaced guide means located two on each short edge of each platform.

4. A suspended staging system as claimed in any preceding claim, wherein said flexible guide elements extend slidably through at least one handrail provided between each of the platforms.

5. A suspended staging system as claimed in claim 4, wherein two such handrails are provided between each of the platforms.

6. A suspended staging system as claimed in any preceding claim, wherein said one or more weights are

submerged in use to a sufficient depth to substantially avoid the effects of wind and wave action.

7. A suspended staging system as claimed in claim 6, wherein said depth is between about 20m to 60m below sea level.

8. A suspended staging system as claimed in claim 7, wherein said depth is between about 35m to 55m below sea level.

9. A suspended staging system as claimed in claim 7, wherein said depth is about 20.5m below lowest astronomical tide level.

10. A suspended staging system as claimed in any preceding claim, wherein a single weight connected to all of said guide elements weighs between about 2 tonnes and about 4 tonnes.

11. A suspended staging system as claimed in claim 10, wherein said weight is about 3 tonnes.

12. A suspended staging system as claimed in any preceding claim, wherein a ladder is provided between each platform, each said ladder being hingedly attached to the platform above and provided with one or more rollers at its lower end, and an opening being provided in each said platform for access to the ladder below.

13. A suspended staging system as claimed in any preceding claim provided with winch means for winding in said guide elements to raise the stack.

14. A suspended staging system as claimed in any preceding claim which is capable of being deployed and/or retracted by remote operation.

15. A suspended staging system as claimed in any preceding claim, wherein a flexible line for the deployment of a life raft is attached to a lower point on the staging system so as to be deployed automatically with deployment of the staging.

16. A suspended staging system as claimed in claim 15 wherein a slidable guide means is slidably mounted on said flexible line and is attached to a life raft by a further short flexible line.

17. A suspended staging system as claimed in claim 16, wherein said slidable guide means comprises a buoyant ring.

18. An offshore escape system comprising a collapsible stairway, a flexible line located adjacent the top of the stairway and attached to a lower point on the stairway so as to be deployed automatically when said stairway is lowered towards the sea, and a life raft slidably connected to said flexible line by a slidable guide means so that the life raft can be deployed from the top of the stairway by sliding down said flexible line after the collapsible stairway has been lowered.

19. A suspended staging system for use in offshore applications, comprising a series of platforms each connected to the adjacent upper and lower platform by respective flexible elongate elements, and a plurality of flexible guide elements connected to one or more weights below the lowest platform and extending slidably through guide means provided on each platform so that successive platforms can be raised and lowered by raising and lowering the one or more weights, wherein said flexible guide elements also extend slidably through guide means provided on at least one handrail provided between each of the platforms.

17

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9214847.7

Relevant Technical fields

(i) UK Cl (Edition L) B7A (AGE ACA); B7J; E1S (SS SLL)

(ii) Int Cl (Edition 5) A62B 5/00; B63B 27/14

Search Examiner

A C HOWARD

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

16 SEPTEMBER 1993

Documents considered relevant following a search in respect of claims 1-17

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2230814 A (LAING) whole spec relevant but see particularly page 3 lines 9-18; page 7 lines 3-28	1, 12-14
X	GB 2151290 A (REED) whole spec relevant, bu see particularly page 7 line 15 - page 8 line 19	1, 12-14
X	GB 1430653 A (TOYO SHUTTER) whole spec relevant	1-3, 13 14
X	WO 92/08518 A1 (LAING) whole spec relevant	1-3, 6, 13, 14

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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